The quantitative approach to business cycle in " X-Crise " group in the 1930's

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X-Crise[1], an Ecole Polytechnique association whose acronym stood for "Centre Polytechnicien d'études économiques" (Polytechnicien Center of Economic Studies), was formed in 1931 in France by Bardet, Loizillon and Nicoletis. Its purpose was to think about the causes and possible solutions to the world economic crisis. Quickly, the feeling of the inadequacy of existent economic theories to the problems prevails in founders' minds. From this feeling results a will to carry a "new glance" on the economic "machine". The Polytechniciens indeed aim at studying economic phenomena in a scientific way, that is, with scientific methods and concepts. In this way, X-Crise is supposed to be ""a center of junction", of passionless discussions, of objective and unbiased examination of modern world problems raised and treated by the scientific method to which the Polytechniciens had been trained" (Nicoletis [1967], 19).

Making economics a true "science": if there is nothing new in this ambition (see Quesnay and the "new science", for instance), it's the contrary for its results. It leads X-Crise members to the construction of the first French mathematical "models" in the nineteen thirties and to the application of quantitative techniques to try to explain economic cycles.

Some of these models have been already presented in French versions by Fischman and Lendjel (see Fischman and Lendjel [1998], [2000a]), or Abraham-Frois and Lendjel ([2001], [2004])[2]. But no attempt has been made to "export" these presentations in english-speaking economic literature. Furthermore, no paper has tried to put these models in the context of business cycles debates. However, some attempts of application of quantitative techniques to economic cyclic movements were made by the brothers Georges and Edouard Guillaume, François Moch or Robert Gibrat. But they were only drafts. Indeed, the analysis of cycles is only a marginal topic in X-Crise seminars. If some members tackle with this topic, as for instance those interested in econometrics (Divisia, Gibrat or Roy), it is not the heart of their thoughts. As a matter of fact, the economic crisis - considered as a moment in a cycle or not - does constitute the main topic at X-Crise.

The first part of this paper is devoted to some interesting drafts of application of quantitative techniques to explain business cycles (1. X-Crise contributions to the mathematical and statistical

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[1] In X-Crise, X is an abbreviation used to identify the Ecole Polytechnique.

[2] Let us note that these French models are still widely unknown in the history of economic thought, even in last continental contributions like Gehrke and Kurz [2000].

analysis of business cycle…). The second part will show that these attempts were limited (2. … are limited contributions).

1. X-Crise contribution to the mathematical and statistical analysis of business cycle

The application of quantitative techniques to explain economic cyclical movements stems from the Polytechniciens' faith in science. According to them, mathematical economics, and especially empirically based modelization, is helpful to build a true economic science. And with the help of scientific methods, they hope to find solutions to the 1930's crisis. These hopes are explicitly developed in methodological debates that Polytechniciens began even before the creation of the association X-Crise (1.1. The methodological debate about empirically based modelization). That leads X-crise to carry a special attention to Georges and Edouard Guillaume's model, elaborated by two non-Polytechniciens X-Crise members, and in a lesser extent, to François Moch and Maurice Potron's models (1.2. Hopes in mathematic models). With these models, X-Crise members tried to confront theories and facts, developing drafts of econometrics approach. Indeed, as we will see, X-Crise participate to the emergence of econometrics in France (1.3. Hopes in econometrics).

1.1. The methodological debate about empirically based modelization

Polytechniciens' hopes in mathematical economics, and especially empirically based modelizations, appear very clearly in their methodological debates on the use of mathematics in economics. These methodological debates pre-exist within the Polytechniciens community before the constitution of association X-Crise. Rueff's book [1922] attests it. Indeed, the conception which will prevail among Polytechniciens is clearly expressed since 1922 by Jacques Rueff, Polytechnicien disciple of Clément Colson, the holder of the chair of political economy at the school at that time.

Rueff is for the methodological unit for sciences. He is convinced that it is necessary to transpose the methods "of physics to morals". He defends thus the idea "of a parallelism of method between economic theory and physical theory" (Rueff [1922], 12; 116), just like after him the brothers Guillaume. This parallelism authorizes the recourse to the use of mathematics in economy, while implying a

> "constant preoccupation with an experimental checking [...], no theoretical principle being allowed and remaining held for valid except if its consequences are confirmed by precise and rigorously established facts" (*idem*, 14, 143).

The thesis developed by Rueff is for the use of mathematics in economy provided that it is accompanied by "the empirical observation of the facts, by statistical way" (*ibid*., 13). It consists, thanks to mathematics, "to draw the permanent relations between economic facts measured by statistical way" (*ibid.*). The recourse to mathematics must make it possible to proceed to a "logical

explanation" (*ibid.*) of economic facts noted by statistical way, constituting from this alliance "a rigorous economic theory" (*ibid.*).

Thus, following Rueff's idea in that methodological point, Boris [1933] underlines, in his presentation of the conference of Guillaume, how the understanding of economic principles is easier, thanks to the use of mathematics (Boris [1933], 3). This merit is also seen by Gibrat [1935] which adds that the mathematical notation has the advantage of requiring a complete enumeration of the elements entering in relation and that it makes it possible to ensure that one does not neglect the action of any factor (Gibrat [1935], 5). Finally, Pourquié [1936] notices

> "what an essential help mathematical logic brings to the researcher by proposing to him coherent and compatible formulas between them. If it is necessary to defy automatic unfolding of the chain of the deductions, one needs a guide of this kind to suggest the assumptions to check "(Pourquié [1936], 26).

A consensus thus appears to reign within X-Crise on the interest of the use of mathematics in economy and on "the importance of the numerical checking of the theories" thus built, as also recalled by Divisia ([1934], 7).

This thesis is maintained again in1937-38 after a conference of Gaëtan Pirou [1937]. He was invited to make a conference in X-Crise on "the teaching of the political economy such as it is understood in the Faculty of Law" (Pirou [1937], 29). This conference will be done "in an electric environment" (Dard [1995], 137) which probably explains the duration of this debate. The position of Pirou consists to protest against a purely deductive interpretation of the economic system. It thus consists to protest against the use of mathematics in order to build a pure economy, unable in its eyes to ensure the comprehension of an extremely complex world (Pirou [1937], 31). On the other hand, it thinks that university economists "intend to start from reality and to get to it" (*idem.*) by means of monographs, of statistical and sociological studies. It is from this "reality", that they build *in fine* the laws. Thus, they show that

> "these laws and these regularities are infinitely more complex than had supposed it a too hasty, too rational, too mathematical interpretation of the economic system" (*ibid* , 34).

Lastly, concluding its intervention, Pirou sums up the conviction of the academics by a concise formula :

> "[t]hey have an enough solid economic culture not to be let charm by the empiricism of the bonesetters and the conjuring of charlatans" (*ibid* , 35).

It is then not surprising to see the assistance - composed as a majority of "charlatans" - highly reacting to these remarks.

Thus Darmois [1937] which intervenes immediately after Pirou defends a position much more favorable to the use of mathematics in economics. Mathematics is, according to him, essential to deduce correctly and to reason with rigour (Darmois [1937], 36-37). But, for him also,

> "if mathematics is of an invaluable help to formulate ideas with precision, to develop means of controlling these ideas, they could not have the force to give ideas to someone who does not have any. One will be able to improve methods of calculation, one should not have too much illusion on the scientific quality of knowledge thus reached "(*ibid.*, 37).

For Darmois too, not only mathematics but still the statistics must be used in economics. According to the theses already developed by Rueff [1922], he defends the idea that economics must be based on the observation of statistical facts and that mathematics must help to build logically theories which could explain these facts (Darmois [1937], 36).

During the discussion which follows the remarks of Pirou and Darmois, Coutrot intervenes to support Darmois against the position defended by Pirou, while insisting on the idea that the facts could not be explained without deductive theory whose mathematics facilitates construction. For him, the experiment must only, then, make it possible to check the theory (Coutrot *in* Darmois [1937], 43). Lastly, making an answer of the shepherd to the shepherdess, Coutrot cannot prevent himself, as a good "charlatan", from answering Pirou:

> "I, for my part, found a very great interest in what MM. Pirou and Darmois said, because I feel that we are at a tragic phase in the evolution of the teaching of the political economy [...] It has to change very deeply and if not to disappear, at least to confine itself in the history of the economic doctrines, if this history still preserves a retroactive interest" (*ibid*).

The "dinosaur" Pirou is thus on the way of its natural extinction in comparison with the inescapable character, for Coutrot, of the mathematisation of the discipline.

In the bulletin of CPEE number 35, of February 1937 two other lecturers - academics - intervene in the debate : Marc Bloch [1937], who defends the historical method, and Maurice Halbwachs [1937] who presents the position of the sociologist. The principal reproach that Halbwachs addresses to the mathematical economy comes from the characteristics of its reasoning: the abstraction. Because the mathematical economy considers the economic subject abstractedly apart from any social bond, or regardless of any institution - as "the monetary economic organization" - (Halbwachs [1937], 27), it is thus led to formulate "strictly empty laws" as "the law of supply and demand" (*idem.* , 28). Then the use of mathematics in economics interests no one except.... the mathematicians. So,

> "I persist in believing that the mathematical Economy is especially interesting as an application of mathematics, and for the mathematicians. For us, it is a novel, a beautiful novel besides. I read Cournot, I read Walras, I read Pareto, and I must say that they did not teach me a lot about reality, about the facts themselves. It didn't seem to me that it could be incorporated in positive science itself "(Halbwachs [1937], 30).

This reserved position concerning the use of mathematics in economics is developed by Nogaro, in the debate after the intervention of Halbwachs. For him, indeed, if mathematics can be useful for economists, the historical method defended by Bloch remains most profitable. It can indeed lead "to an interpretation much more probable and precise than the one that the deductive method would offer us " (Nogaro *in* Halbwachs [1937], 32); moreover, Nogaro underlines, following Bloch, that the historical fact plays "like a happy experiment of laboratory" (*idem*.); finally, the historical

method offers "possibilities of interpretation" which do not exist with the deductive method (*ibid.*, 33). These three theses were also shared by Lacoin during this debate.

However, this position could not dominate within X-Crise. The debate continues thus in the following number of March 1937 with a conference of Jean Ullmo [1937]. He defends the use of mathematics while placing itself explicitly against the position of Pirou. The advantage of mathematics lies indeed initially in the rigour which they impose on economics. Then, it lies in their ability to solve the problem of polysemy of the vocabulary and of economic definitions.

> "We stressed two essential defects of the contemporary economics : use of vague definitions, and of reasoning with purely verbal analogies. Isn't it better to look for precise definitions, and, if analogies are wanted, to take them in models including an analogy with reality, having a resemblance to the real systems?" (Ullmo [1937], 9).

The solution thus consists in creating - in accordance with the position of the Vienna's circle - a scientific (or mathematics) language common to the whole community of the economists without which science would be, according to him, impossible.

> "And thus in economic science the need, the urgency of a preliminary work appears: to specify the definitions, to determine the elements of economic phenomena to measure, in a word to create a common language […] on which science can be based on "(Ullmo [1937], 9).

Thus, Ullmo follows the very recent recommendations of "International Congresses for the Unit of Science", an institutional emanation of the logical empiricism of which the first congress was held in Paris, in the Sorbonne, in September 1935[3]. An advertising insert for this congress appears even in the last page of *the Bulletin of C P. E E.* n° 24-25, dated July-August 1935, in which one finds the following extract :

> "[t]he congress of Paris will endeavour to define the methods and the nature of the scientific knowledge (logical of science, logical syntax of the scientific language, scientific empiricism, pseudo-problems due to the language, etc....)".

For Ullmo, the constitution of a common language is only one stage so that the economy becomes a science. A true axiomatic in economics must still be developed, controlled by statistical experiment (Ullmo [1937], 9).Otherwise, the model incur a major risk expressed by Divisia in 1938 after Gide:

> "As one said extremely well, wrote Charles Gide," mathematics is only one mill which returns to the state flour the corn that one brings to him, but it remains to know what this corn is worth "(Gide and Rist, *Histoire of the economic doctrines*, 1920, 643)" (Divisia [1938a], 193).

It is to avoid this risk that Polytechniciens agree about the need for statistics. A conference of Rene Roy will ended the discussions on this topic within X-Crise, still defending this approach. "Scientific economics" ([1938], 12) is indeed, according to him,

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[3] Let us note that the epistemological positions that Ullmo into 1969 develops testify to multiple influences. One finds in this work the traces of the operationalism of Bridgman, the mark of the logical empiricism of the Circle of Vienna, as well as broad extracts of work of Bachelard.

> "like a bridge thrown between these two opposed designs, because it tries to use at the same time the processes which proved reliable in the field of physics and the observation of facts, by a systematic and rational use of the statistical processes" (Roy [1938], 17).

One thus finds the position defended since the beginning within X-Crise of an economic science which is at the same time mathematical and statistical, such as econometrics. As we will see it now Moch's work certainly is the only Polytechnicien's one at that time which was successful from this point of view. Indeed, Moch 1/ developed a mathematical model, 2/ tried to deduce from it a theoretical interpretation of the cycles and 3/ attempted to confront its theory and facts, developing as soon as 1933 drafts of econometrics approach.

1.2. Hopes in mathematic models such as Moch's one

The first french economic models were developed or presented at X-Crise. Trying to put forward an economic analysis of the crisis and its remedies, their members afford a dynamic approach of the Great depression, with a cyclic version in the case of the Guillaume and, in a lesser extent, of Moch. The latter's one deserves to be briefly presented here as an example since 1/ it's a 100% Polytechicien-made model (contrary to the Guillaume brother's model) and 2/ Moch developed a "draft" of an econometric approach of business cycle that we will see in the next section. Surprisingly, this model will never be discussed[4], despite it deals with a cut in working hours subject, debated at length in X-Crise[5]. It's also the case of Potron's model (see Abraham-Frois and Lendjel [2005]).

François Moch's model was published in 1933-1934 in X-Crise's bulletins. It attempts to determine the consequences on the economic system of a cut in working hours through the analysis of a wage variation. In fact, Moch considers that the economic system can't spontaneously get out of an under-employment equilibrium. Only a State intervention, by acting on revenues and, thus, on demand, can help to get out of this situation.

Moch's model is probably inspired by Guillaume's one. Like the Guillaume, Moch introduces time in his theoretical frame by using differential equations. But he doesn't try to characterize these equations, neither to solve them.

> "The purpose here is to proceed, in the analytical domain, to a similar description not as the Geometric one, but as the Analyse Situs one : it will only depend on the general feature of phenomena, and keep valid even after some rather perceptible distortions" (Moch [1933-4], II, p. 34).

Moch's model is based on five groups of equations.

The first group describes the " production's equations". The first one depends on labour input only.

> "For a given state of techniques, the number of objects *i* [in a quantity A^i] produced in a unit of time is proportional with the number of workers α' directly employed in production (from raw materials' extraction to the finish of the product):

[4] If these discussions occurred, there were not reported.
[5] See Lendjel Fischman[2000a].

[11] $A^i = l^i P_{\alpha'i}$ (i = 1, 2, ..., *n*)" (Moch [1933a], p. 31).

In Moch's notation, the output A^i of commodity *i* depends on the volume of labour $P_{\alpha'i}$ directly used in production (with P, the number of people and α' the workers directly employed in the production of the commodity *i*), multiplies by a coefficient l^i which designates its productive power or its productivity[6].

The second equation describes the stock's variation dS^i during the time *dt*. It's equal to the difference between the quantity produced A^i and the quantity consumed c^i of the commodity *i* during this time:

[12] $dS^i = (A^i - c^i)dt$ ($i = 1, 2, ..., n$)

The third equation describes the variables on which the employment depends.

> "We will assume [...] that each industry adjusts its hiring α' in order to maintain an equilibrium between production and consumption. [...] there will be a variation dP $P_{\alpha'i}$ of the number of workers, so that A^i varies from d_1A^i, equal with $dc^i - dA^i$ " (Moch [1933-4], II, p. 31).

The number of workers varies from dP $P_{\alpha'i}$ till production fits to the level of consumption. As Moch includes time in its reasoning, the l^i coefficient, which designs the labour's productivity depending on technique, varies from dl^i too. Consequently, the production's variation has two effects: the quantity of labour's variation and the productivity's variation. That is to say :

[13] $d_1A^i = l^i dP_{\alpha'i} + P_{\alpha'i}dl^i$

As d_1A^i must be equal to the difference between $dc^i - dA^i$, and because [11] $l^i = A^i/P_{\alpha'i}$, we have the following formula :

[14] $$dP_{\alpha'i} = \frac{dc^i - dA^i - P_{\alpha'i}dl^i}{A^i} P_{\alpha'i} \quad (i = 1,..,n)$$

Thus, the number of workers employed in the industry *i* depends on the evolution of technique and, above all, on the difference between consumption and production of the commodity considered.

> "the equation [14] expresses that production aims to follow the consumption's variations, but only with the hiring or the dismiss of workers $P_{\alpha'}$ (the variations d*l* being determinated by the technique). It is not *a priori* sure that the production will not naturally tend to grow more than consumption and, consequently, that unemployment will not rise up" (Moch [1933-4], II, p. 34).

By this way, Moch expresses the Keynesian primacy of demand in the determination of the production and employment's levels.

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[6] Curiously, Moch seems to forget an equation in its model. Indeed, the manufacture of the tools necessary to the production, which requires labour ###", in quantity P ###", is described by no equation. The evolution of the investment thus seems to intervene only in an exogenic way, through the coefficient L^I.

The second group describes the " management's equations". Among these equations, the first one is related to cost price. Moch distinguishes here the production of consumer goods from the one of production goods. The first one is financed with the sale of commodity, when the second one depends on loan, thus on saving and credit circuit.

> "The turnover helps to only pay the wages of the workers α' employed in the production (and the servicing of the material). Net loans - instantaneous loans, eventually less depreciations and reserves taken from benefits - are used to pay all the wages α" of workers employed in the new equipment manufacture, and a part of their own interests, as it has been said (the rest figuring in the cost price)" (Moch [1933-4], I, p. 31).

Thus, the equation of cost price r^i concerns only consumers goods[7].

[21] $A^i r^i = P_{\alpha'i}\ s_{\alpha'i} + C^i \quad (i = 1, ..., n)$

where $s_{\alpha'i}$ designates the "instantaneous wage" of workers α', and C^i the "load of instantaneous capital of the industry *i*".

Among these management's equations, Moch makes a census of six others equations related to net loan, load of capital, loans, depreciations, reserves and credits (Moch [1933-4], I, pp. 31-32). Lacking of space, we will not mention them here.

The third group of equations describes the formation of agents' revenues. Moch distinguishes between three kinds of agents: workers ($P_{\alpha'i}$ et $P_{\alpha''i}$), employers $P_{\beta i}$ and persons of independent means $P_{\beta 0}$[8]. The revenues of workers $f_{\alpha i}$ come from salaries $s_{\alpha i}$ increased by savings' interest $\int \varepsilon_{\alpha i}\ \tau\ dt$:

[31] $f_{\alpha i} = s_{\alpha i} + \int \varepsilon_{\alpha i}\ \tau\ dt, \qquad (i = 0,1, ..., n)$

The employers receive a profit ($c^i v^i$ - $A^i r^i$), less depreciations (F^i) and reserves (R^i), plus their savings' interest $P\beta_i \int \varepsilon_{\alpha i}\ \tau\ dt$:

[32] $P_{\beta i} f_{\beta i} = c^i v^i - A^i r^i - F^i - R^i + P_{\beta i} \int \varepsilon_{\beta i}\ \tau\ dt, (i = 1, ..n)$

The revenues of persons of independent means and of financiers come from the interest of their savings $P_{\beta 0} \int \varepsilon_{\beta 0}\ \tau\ dt$ and of credits' interest $\int H\ \tau\ dt$:

[33] $P_{\beta 0} f_{\beta 0} = P_{\beta 0} \int \varepsilon_{\beta 0} \tau\ dt + \int H\ \tau\ dt.$

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[7] It thus seems, in the absence of equation characterizing the production of the tools, that the investment is identified in the model only by its mode of financing.

[8] Moch ([1933], p. 28) considers that index 0 indicates the non-producing sector of goods. The unemployed ones, which is thus people not producing goods, are noted α_0 and shareholders, β_0. In the same way, the saving will be considered by Moch as "a consumption of product 0 " (Moch [1933-4], I, p. 32).

The revenues of these three kinds of agents will be used for consumption and savings, according to the idea that savings (designated by the suffix 0) are considered as a consumption of commodity 0 (Moch [1933-4], I, p. 32). Indeed, the whole savings is considered as an investment, so that there isn't any hoarding (Moch [1933-4], I, p. 28). Savings being necessarily equal to investment, it may be considered as consumption.

This group of equations is of great importance for Moch. Indeed, from the distribution of revenues depends the dynamic equilibrium of the economy:

> "The distribution of revenues determines, obviously, the extension's possibilities of each market" (Moch [1933-4], II, p. 35).

Indeed, the distribution of revenues influences the volume of consumed commodities, knowing that a worker consumes proportionally more than an employer or a person of private means. Thus, the following equation indicates the variation of consumption in value $d(c^i_\lambda{}_j v^i)$ of the individual λ [34] :

$$d(c^i_\lambda{}_j v^i) = q^i_\lambda{}_j dv^i - k^i_\lambda{}_j (df_\lambda{}_j - \sum_{h=0}^{h=n} q^h_\lambda{}_j dv^h)$$

$$\text{avec} \sum_{i=0}^{i=n} k^i_\lambda{}_j = 1, \qquad \begin{cases} \lambda = \alpha', \alpha'', \beta, .. \\ i = 0, \ldots, n \\ j = 0, \ldots, n \end{cases}$$

The coefficients *k* et *q* figure the relative importance given by an individual to every commodity consumed. They depend on needs and tastes of the individual, on its revenues and on some commodities' prices. Thus, consumption rests only on tastes, prices and revenues.

Because workers consume proportionally more than employers or persons of independent means, the possibility of markets' expansion will in a crucial manner depend on the increase of their revenues. To put the workers' revenues at a disadvantage implies to risk a progressive saturation of markets, with, then, an increase of unemployment.

Finally, the two last groups of equations end the model. They are, on one hand, the "agreements' equations" which

> "express the forces' action - competition, supply and demand - which acts to determine the terms of an agreement on any market (products, work, pension), that is to say to fix the sale prices, the wages and the interest's rate (supposed to simplify unique at a definite moment" (Moch [1933-4], I, p. 35).

The main equation is the one which describes the process of price formation:

[41] $dv^i = (v^i / r^i)\, dr^i - V^i r^i dS^i \qquad (i = 1, ..., n).$

The price variation depends on that of cost price dr^i and on "the variation of the fierceness of competition at the period of time considered", that is to say the trend of creation or fading of stocks dS^i weighted by the coefficient V^i (Moch [1933-4], I, p. 35).

On the other hand, the "demographic equations" describe the dynamic evolution of the whole population, that of employers, of workers and of unemployed which depends on the three first other one. Most of them are "experimentally" determined equations.

Being equal with the unknowns,

> "[o]ur equations [...] completely specify the system's evolution, taking into account the technique's evolution" (Moch [1933-4], II, p. 34).

Thanks to this model, Moch can evaluate the impact of a variable change (wages' variation) on the model.

> "In the first place, the repercussions of an elementary event (wages' variation), then, the general evolution of the system left to itself will thus be followed step by step - I mean here that one will simply try to determine the variations' directions of the main features -" (Moch [1933-4], II, p. 34).

Its research on the effects of working time decrease takes place within this framework.

We will not tackle here with Moch's analysis of these effects (see Fischman and Lendjel [1998]). We will simply retain the coherence of this model and the keynesian character of one of the first French macroeconomic models – three years before the *General Theory* -. It testifies, as Margairaz wrote it, how "X-Crise have eased Ecole Polytechnique's conversion to Economics as well as the State experts to macroeconomics, more or less explicitly inspired by Keynesianism" (Margairaz [1995], 181). Potron's model strengthens this idea. But we will now see how furthermore Moch deduces from his model a theoretical interpretation of cycles and how he tries to confront it to facts, providing thus a draft of econometrics – also contributing, with other X-Crise's Polytechniciens, to the emergence of econometrics in France at that time.

1.3. Hopes in econometrics

The Polytechniciens' contribution to the emergence of econometrics in France is primarily of an institutional nature. We know that Divisia takes part in the international econometrics society from its beginning, recalling, within X-Crise, its work and methods (Divisia [1934]). But the Polytechniciens' interest for econometrics appears essentially through reports on works developed in this field. Indeed, Polytechniciens will never study themselves econometrics within X-Crise. They will never present works of an econometrics' laboratory which they would have created[9]. *C P. E E.*'s bulletins testify it. The only procedure of "test" is Moch's 1933-4 "draft" that we will present here. But, as we will see, it is of graphic type and does not correspond to the tools developed in this incipient discipline. The use of these tools is just illustrated through Tinbergen's presentations in July 1938 and June 1939. Nevertheless, the whole of this activity reveals the importance that Polytechniciens grant to econometrics.

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[9] Divisia creates the first laboratory of économetrics in France in 1941 (Armatte [1994], 433).

An Institutional support

X-Crise main contribution to the emergence of econometrics is of institutional nature. It derives from Polytechniciens' will to be always on the top of the knowledge. The sense that they embodied the republican aristocracy was their fundamental value (Nicoletis 1967, 19) from which, indeed, arose the form taken by their collective reaction. The habit of making up groups around specific fields of interest and the maintenance of an "esprit de corps" outside of the school per se explain, to a considerable extent, the founding of X-Crise. This value system also accounted for the open-mindedness[10] and scientific focus of this group. Their sense of elitism (Bardet 1931, 47), in fact, encouraged them to follow scientific progress closely :

> "The sciences are in a total state of ferment. To ignore this movement and persist in a disdainful immobility would be equivalent to suicide" (Le Chatelier 1924, 21).

This was probably one of the factors that would lead the group to become interested in the emergence of first french economic model and of its corollary, econometrics. Gibrat wrote thus :

> "it would be regrettable that [our group] does not have its share of this new science whose prolongations are specified each day" (Gibrat [1936b], 98).

The most tangible factor of X-Crise'support for the emergence of econometrics appears in the "Notes on the Econometrics" published regularly by Gibrat between 1934 and 1936.

In his first "Notes on Econometrics" (Gibrat [1934]), Gibrat underlines proudly that, among the 41 Frenchmen taking part to the Econometric Society in 1934 (among 463 members), 17 are Polytechniciens, 15 professors (of University), the others being primarily bankers. Among Polytechniciens, Gibrat quotes Colson, Chayrou, Barriol, De Ponteves, Huber, Marlio, Wolff, Camille, Galliot, Divisia, Corbeiller, Bérend, Roy, Masse, Rueff, Bardet, Gibrat. Among the professors, he quotes Allix, Antonelli, Borel, Bounatian, Darmois, Frechet, Gumbel, Hadamard, Halbwachs, Landry, Picard, Pirou, Rist, Simiand, Truchy.

Gibrat's Notes furnish regular progress reports on what is done in econometrics. Indeed, says Gibrat, his work consists

> "periodically to review here the principal contributions to this rather new discipline" (Gibrat [1934], 25).

The "*Econometrica* review will provide us the main content of our notes" (*idem*.), he affirms, while immediately adding,

> "[w]e will detach from the main world economic reviews the articles which will seem to us to be relative with our subject, and even, when the opportunity arises, we will not hesitate to study books in these "Notes"" (*ibid.*).

The content of these Notes is the following. In fact, the "Notes" II, III, and V (Gibrat [1935a], [1935b], [1935e]) are eulogistic reports of Roy's work [1935] on "the Economic Indices and the Laws of

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[10] Gérard Brun described X-Crise as "an oasis of serenity" allowing a true "socio-political melting pot" where interventionists and liberals could meet (Brun 1982, 21-23).

demand", of G Darmois'one [1935] entitled "Statistical and Applications", and of Luftalla's paper [1935] published in *Sociological Annals* on "the difficult question of the curves of supply and demand". Only the "Notes" IV (Gibrat [1935d])[11], VI (Gibrat [1935g]) [12] and VII (Gibrat [1936a]) [13] to which it is necessary to add the presentation of a Frisch's work (Gibrat [1935b]) present papers published in *the Econometrica* review[14].

It's in this direction too that he creates, with the assistance of George Guillaume, a group of Polytechniciens who will gather informations on the econometricians' works, the team of econometrics. The aim of this team essentially is "to be informed" of what is done in the field, but absolutely not to create a laboratory of econometrics.

> "We formed with the assistance of Mr. G Guillaume, a few months ago, among the young Polytechniciens, a small group in order to create a research in this field of economic science. This small group reads the reviews and, thus, is informed of what is published everywhere about economic science "(Gibrat [1935f], 6).

This institutional support will help to diffuse these new techniques in France which will be essential for the constitution of the Plan, the INSEE, and other French organizations of the post-war period.

Moch's "draft" of an econometric "method" to interpret economic cycle

The unique attempt to confront theories and facts through a kind of econometric approach can be found in François Moch's "appendix" of his 1933-4 contribution[15].

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[11] where Gibrat presents an article of Benjamin Greenstein [1935] on the application of the analysis of the périodigrame on the bankruptcies to the United States.

[12] when Gibrat presents the statistical study of the prices out of purse of Szeliski [1935].

[13] where is presented work of Frederick Ross [1934] "studied the influence of the prices, is passed, present or future, on the request of the corresponding goods" (Gibrat [1936], 91).

[14] It will be noticed that the "Notes" of Gibrat cease in 1936 after the "Notes" VIII. Perhaps the explanation is due to a conflict of people explicitly open in the "Notes" VIII by Gibrat. Indeed, Gibrat posts in these last "Notes" its will to make CPEE a body of proposal and not only one place of debate. Gibrat indeed referred there to a "group of Scandinavian technicians" (Gibrat [1936b], 97) wanting "to carry out a connection between the technique of the engineer and the art of the economist" (*idem.*). However, Gibrat underlines,

> "[i]l would have there to say much on such a statement of principle; in particular the differences with the objectives with the CPEE jump to the eyes. The Scandinavian engineers want to build and not to expose or inform; also can they hide their social or human occupations behind correct reasoning. Above passions they will raise, stone by stone, if the life allows them, a stable building whereas our work must constantly die to live "(*ibid.*).

By doing this, Gibrat proposes to break with what does one of the originalities of this group, firmly defended by Coutrot in particular. On this point to see Dart [1995], 144.

[15] Moch's paper has been published in three parts in the *Bulletin du C.P.E.E.* : Part I in n° 7, oct.-nov. 1933, pp. 24-39; Part II in n° 8-9, déc. 1933, pp. 34-44; Part III in n° 10, fev. 1934, pp. 18-27.

Resting on Guillaume's *cinémogramme*[16], François Moch – the brother of the French socialist Jules Moch - proposes,

> "the draft of a method which could help to interpret some statistics and to confront theories and facts" (Moch [1933-4], III, 27).

This method tries to characterize the market in order to follow its evolution. For that purpose, Moch supposes that

> "[the] state of the market, for a given product, can be characterized, at one given moment, by the relative surplus (positive or negative) of the production [A] on consumption [*c*], and by the relative surplus (positive or negative) of the selling price [*v*] on the cost price [*r*]. Let be *h*, the latter quotient (v - r)/r of the excess benefit and p, the former percentage of overproduction (A - c)/c " (*idem.* , 28).

So these successive states of the market can be reported in a two axes figure, with the percentage of benefit (*h*) on the first axe and the percentage of overproduction (*p*) on the second one.

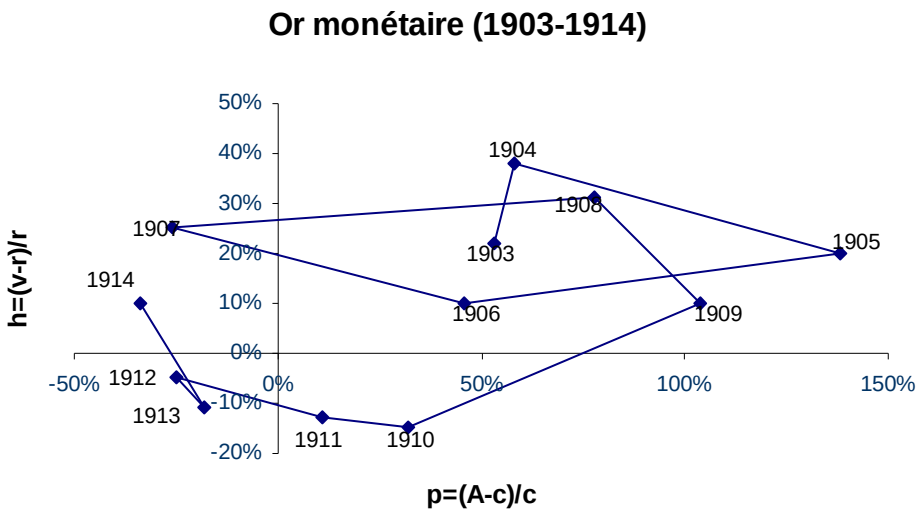

Figure 16

> "A point of the plan will correspond to the state of the market of a given product at a given moment; and the market trends for a certain period will define a curve" (*ibid.* , 28).

Each point thus represents a state of the market on a given date. By connecting these points between them according to their temporal succession (figure 16), Moch points out that

> "while following this curve in the direction of increasing times, one turns constantly towards the right (except a small exception, maybe due to the inaccuracy of the graph, or to particular circumstances)" (*ibid.*).

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[16] The *cinémogramme* is, as the word suggests it, a simple transposition from the cinematograph's principles to the dynamic representation of economic phenomena (Guillaume [1932], p. 181).

This curve describes precisely to the theoretical behaviour of the gold market, based on Guillaume's data on gold market between 1903 and 1914:

> "Indeed, in the first quadrant (fig. 17), the benefit is positive:

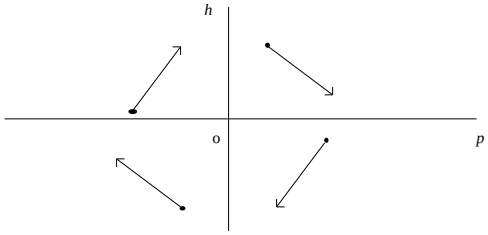

Figure 17

> Hence, the production will tend to increase (at least as long as the benefit will remain higher than a certain minimum); but when the production exceeds consumption, the benefit will thus tend to decrease. The representative point will consequently tend, in theory, to move in the direction of the arrow; and likewise, mutatis-mutandis, in other quadrants. Of course, the more these trends will be accentuated in each quadrant, the more they will be distant form the axes " (*ibid.*, 28).

This graph thus describes the theoretical behaviour – cyclical - of the gold market[17]. In the event of important benefits (nord-east quadrant), the producers develop their output, producing more than needed. An increasing overproduction (rise of *p*) brings a decrease of profit *h*. Then, with important overproduction level (south-east quadrant), the benefit, becoming negative, involve a reduction in overproduction until it becomes negative. Hence the rotation's direction of Moch's cycle in this graph. Let's us note that Moch is aware of the role of individual expectations on the market behaviour :

> "Trends may be more or less modified by individual behaviours due to their more or less precise and delayed knowledge of the actual situation" (*ibid*., 28).

Two equations ([A] and [B]) give support to this theoretical description of the behaviour of the gold market, according to Moch.

[A] $dh = - V (p - p_0)\, dt$

[B] $dp = K (h - h_0)\, dt - A dc/c^2$

where V and K are constant and p_0 and h_0 minimum values. The first equation asserts that profits variations are function of overproduction, with a minimum value. The second one describes the reverse, with a minimum value for overproduction, but overproduction also depends on the evolution of consumption.

> "Assuming that consumption does not vary ($dc = 0$), these equations would together form an ellipse in figure 17. Taking account of [this assumption], these equations seems able to describe satisfyingly the graph of figure 16 [reporting empirical data of the gold market]" (*ibid.*, 29).

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[17] Let us raise however that the "data" on which Moch rests suppose that one can measure the difference between a selling price and a cost price and, especially, the difference between the production and consumption.

Thus, Moch's attempt to explain theoretically the cyclical characteristics of the gold market data relies on a graphical comparison. Moch's confrontation between theory and facts only rests on a rough graphical analysis. He uses no statistical test since he probably doesn't know them. Indeed, it's only the "draft of a method", as he claimed (*ibid.*, 27), but a useful draft if this method could become a consistent one.

> "It would be a useful – and maybe necessary – tool for anybody wishing to "guide" fully-informed the economy" (*ibid*., 30).

Indeed, Moch describes what could produce the extension of his reasoning to other important markets

> "Let's imagine that other important market curves can be reported on the same graph; by the way, a proportional scale to the volume of transaction may also be chosen for each market at the beginning. The relative importance of perturbations on various markets and their propagation from a curve to the others, may let appear clearly the real role and the relative importance of the various factors of the crisis" (*ibid*., 29).

He suggests also to incorporate individual behaviours :

> "These "material" data will be much more interesting if one supplements them by analogous "personal" data. One can, indeed, characterize a given category of individuals (for example: farm labourers of an area; average civils servant; administrators of banks; etc...) at a given moment by the relative instantaneous variation of the number of these individuals (analogous with the percentage of overproduction) and by the relative instantaneous variation of their average income (similar to the percentage of benefit). One will be able to build thus, for each category of individuals, a "personal curve" similar to the "material curve" built for each product. While carrying on the same graph the principal material and personal curves, one would see them obviously at the origin of a crisis a very different overall pace, according to whether it would act of a monetary crisis or credit (insufficiency of the means of payments in general), of an economic crisis (relative imbalance of the various productions) or of a social crisis (insufficient purchasing power and underconsumption of a category of individuals). The origin of the disturbance would be, in the first case, on the curve of gold (or a curve of the appropriations), the material curves on the one hand and the personnel curves on the other hand remaining quite parallel in each group. In the second case, there would be divergence of the material curves, and rhythm break on those which would move away more towards positive *p*. In the third case, there would be divergence of personnel curves, and rhythm break on the material curves corresponding to the products most sensitive to the market concentration (produced accessible to the individuals disadvantaged, but considered by them as being a luxury)" (*ibid.* , 29-30).

Thus, Moch's draft could also recall the recent rise of the use of individual data in nowadays econometrics.

Other draft

Another aborted draft can be noted with Gibrat who, in a discussion with Coutrot, proposes to use Van der Pol's equation to describe the economic crises theorized by Marx. As follows:

> "You make me foresee the possibility of a differential equation in which the divinity would be represented (*laughter*). Seriously it should well be seen that the natural oscillation of the economy cannot be sinusoidal and for example the design Marxist of the class struggle is reduced to the theory of a relaxed oscillation. Here the talk of Marx: Each year, there is in consequence of the development of sciences, an improvement of the means of production which corresponds so that Coutrot calls "the rate of rationalization". The forces of production growing, it arrives one moment when, by their growth even, they are not any more balance with the existing balance of property [...] This immense building, erected scaffolding on the balance of production, cannot adapt to the continuous changes. It comes one moment when

> there are shock, crisis and revolution. This process is exactly that of the discharge of the neon tubes of the neon signs "(Coutrot-Gibrat [1935], pp. 48-49).

Thus follows the list, enumerated by Van DER Pol in 1928, of the phenomena to which the equations of Van DER Pol are suitable for apply:

> "the wind harp, the pneumatic drill, the noise of a knife which one scrapes on a dish, the floating flag in the wind, the buzzing noise made by a water tap, the periodic sparks of the Wimsthurst machines, the switch of Wehnels, the cracking of a door, the multivibrator Abraham and Bloch, the multivibrator tetrode, the intermittent discharge of a condenser through a neon tube, the periodic reoccurrence of the epidemics and economic crises, periodic cycles of an even number of species of animals living together, one being used as food with the other, it sleep of the flowers, the periodic reappearance of the waves during a depression, quivering due to the cold, menstruation and finally beats of the heart. One tends more and more to regard these oscillations as fundamental, and I could not resist the desire to adapt to it the famous diagram Marxist" (Coutrot-Gibrat [1935], 49).

Gibrat will stop with this simple idea, without trying to give an explicit modelization of it. The interest, for us, lies precisely in this interruption.

Why such a stop, while at the same time the subject - the crisis - worries all the members of X-Crise? The explanation is probably side of the epistemological positions impregnating Polytechniciens in these years. Gibrat is even one of the figures, since it takes part in the rise of econometrics in France. It is indeed side of the scrupulous attention to the "facts", the statistics, "the experiment", which one finds the explanation of this hesitation. Mathematical models certainly are necessary for the Polytechniciens. But as we already mentioned it, they always must be counterbalanced by the study of facts. The rejection of the pure walrassienne economy and the assimilation of science to econometrics testifies it. If one sticks to the case of Gibrat, the obstacle with the unbounded use of mathematics resides in a conscious epistemology - pragmatism -, if not at least in a scientific culture which maintains an indefectible link with experiment.

2. Limits to this contribution

In this second part, we will see how, embedded in the thirties' crisis' analysis – and of its solutions – the attempts to include business cycles in models and to apply quantitative methods are in two ways restricted. They are restricted because of the Polytechniciens' difficulties to understand the econometric approach – its concepts and its epistemology –, those looking only after a tools to intervene in the economy. These difficulties lead them for instance to miss the probabilistic bend of econometrics. (2. 1. An approximate representation of econometrics). They are restricted because of the lack of debate about the most novative models presented within X-Crise (Moch's and Potron's ones). Here, we have the feeling that the Polytechniciens have their mathematical model of the crisis with Guillaume's work and that it's enough for them (2. 2. A limited interest for mathematical models).

2.1. An approximate representation of econometrics

When one examines in detail the presentations submitted at the CPEE under the label of econometrics, it emerges rather the impression of vagueness as well conceptual as epistemological: vagueness in the definition of econometrics, its methods, what it includes and its epistemology. It is necessary to await the two Tinbergen's interventions, in 1938 and 1939, so that a precise image appears. The most plausible interpretation is thus the following one: Polytechniciens have straightaway given an institutional support for econometrics, while making a progressive training of its contents. This gap corroborates, according to us, the motivations which led Polytechniciens to support econometrics: their will to act, their system of value like their pragmatist epistemology.

Five arguments come to support this interpretation.

A fluctuating notion of econometrics

The first argument is connected with the inaccuracy of the econometrics' definition in various communications. This vagueness appears particularly in Gibrat's econometrics' notes.

At the beginning, Gibrat takes up the definition of econometrics stated in the statutes of the Econometrics Society whose Divisia had been already made the echo (Divisia [1934], 7). Thus, for Gibrat,

> econometrics [...] intends to "unify the theoretical quantitative treatment and the empirical quantitative treatment of economic problems" using studies which "are characterized by a methodical and rigorous spirit similar to the one which reigns in sciences of nature "" (Gibrat [1934], 25).

However, to define econometrics seems difficult to him (*idem*., 26). Interested by a work of Razous [1934], Gibrat is led to specify what he understands by econometrics. In fact, this work treats of an object which does not correspond, according to him, with the meaning of the word econometrics defined by "its inventors" (*ibid*., 25)[18]. For Razous, underlines Gibrat, econometrics is

> "the measurement of the effects of the various solutions likely to be adopted in the economic and social organization of a country" (*ibid*).

However, "[t]he understanding of the mechanism of these solutions, the interpretation of their effects" (*ibid*.) also formed a part of econometrics for Gibrat. For, econometrics is not defined by the

[18] Gibrat underlines besides notes of it that Razous is "the secretary-general of the Institute of the Actuaries" and that "curious thing, it forms part neither of the Company of Econometrics, nor of the CPEE" (Gibrat [1934], 25, note 4).

delimitation of its field of activity but by its manner of dealing with the problems arising. Indeed, he writes,

> "[w]hat characterizes its followers, is a taste of quantitative, not only in the "measurement of the effects", but also in the definition of the concepts, the investigation into the causes, the study of organizations" (*ibid.*).

This definition of econometrics as taste for quantitative is reaffirmed by Gibrat when it reproaches Razous for confusing econometrics either with mathematical economy, or with statistics. Thus, econometrics is neither one neither the other, nor, as it would have been possible to expect it, a subtle combination of this two knowledge. Econometrics, in its eyes, is summarized in "a state of mind" (*ibid*.).

> "Mr. Razous [...] appears to confuse econometrics, sometimes with the pure and simple mathematical economy, sometimes with the statistics. It is neither one nor the other, we believe, but a state of mind "(*ibid.*).

From this point of view, Gibrat is then led to reproach Razous for referring to François Moch's work in order to speak about econometrics. Indeed, this work is only a qualitative one, according to Gibrat, who qualifies it as an "excellent mathematical political economy" (*ibid*., 26). On the other hand, it is the case neither of Louis Kahn's work, nor of Guillaume's one, also quoted by Razous. The first would be econometrics within the meaning of Razous, according to Gibrat. Indeed, it would use "seizing charts of phenomena" and make prediction, thanks to "justified extrapolations of the future feature of phenomena"" (*ibid*., 26). As for the second, Gibrat would readily classify it in econometrics even if he admits that G and E Guillaume "almost certainly [...] would not accept our judgement" (*ibid.*).

In 1935, its position evolves with regard to Guillaume's work. He estimates indeed that their work is "halfway between this stage [that of the excellent mathematical economy of work of F Moch] and that of econometrics" (Gibrat [1935f], 6). Nevertheless, noting again the disagreement on this point with G and E Guillaume themselves, he also underlines this time the width of it

> "[i]t would undoubtedly be necessary a whole book so that we can agree with them on this point" (*idem.*).

In front of these definition's difficulties, Gibrat however estimates that he provided "sufficiently varied examples of econometrics [in its "Notes"] so that our readers can have a rather complete idea of it" (*ibid*.).

Frequent needs for a synthesis

A second argument can be advanced to show the progressive character of the training of Polytechniciens. Periodically, a speaker takes time to present in a synthetic way econometric's work. It is, first, the communication of Divisia in December 21, 1933 entitled "Work and Methods of the Econometric society". It is then the communications of Pourquié [1936], Darmois [1937], Chait [

1938], and finally Tinbergen [1938] and [1939]. Meanwhile, from its first note in 1934 to its resignation in 1936, Gibrat monopolizes a great part of the speaking time on the topic of econometrics. Thus, it seems necessary, for the members of C P E E, to think periodically about the subject of econometrics, its methods, its interest.

A difficult assimilation of econometric concepts

The third argument is based on the difficult assimilation of econometric concepts by the CPEE's members.

The only macro-economic works of the CPEE are the Guillaume brothers, Potron and François Moch'ones. But they do not lead to econometric tests to be strictly accurate. It is necessary to await the communications of Tinbergen (in 1938 and 1939) to profit from the first results of a true econometric study.

In addition, of its own consent, Gibrat does not seem to understand well the process by which one can identify a demand function and a supply function starting from two statistical series on the prices and the exchanged quantities. This method, which he allots to Leontief, is not other than the "method of the delay", formulated originally by Moore, and simultaneously taken again by Ricci, Schultz and Tinbergen in 1930, to found the diagram of Cobweb. Gibrat exposes it as follows:

> "[Leontief] divides the points of transaction into two groups including an equal number of points and adjusts by the method of least squares a couple of straight line on each group, while forcing these lines to be common to both groups" (Gibrat [1935e], 66).

To understand it, some elements must be mobilized which are not evoked by Gibrat. These elements were developed by Schultz since 1928. Schematically, the method of the delay consists in "delaying" a series compared to another. If one takes two time series (one relative to the prices of goods given, the other to the exchanged quantities), two configurations are then theoretically possible if they have both the same cycle: either there is a perfect negative correlation (R = - 1.0) and, in this case, one obtains a demand curve; either there is a perfect positive correlation (R = + 1,0) and a supply curve is obtained. If it is supposed that there is a perfect negative correlation between the prices of goods at one given moment and its consumption at the same time, while supposing that there is a perfect positive correlation between the price at the current period and the production at the next period, then one obtains two distinct curves, one of supply and the other of demand. The same statistical series make it possible to obtain two curves if one shifts in time one of the series compared to the other[19].

Gibrat probably knows this process, since he implicitly referred to it concerning the diagram of Cobweb, after an intervention of Dugé de Bernonville.

> "Here, for example, a very simple thesis, Tinbergen Dutchman's one, about business cycles on the economic situation, theory - I hasten to add – that he has since considerably developed. He

[19] On this method, to see Lendjel [1998], p 161 and following.

> starts from the results of a German, Hanau, about the formation of pig's price. He had shown the presence of three or four years very clear cycles in the prices and the quantities of this meat species. These cycles are very well explained by considering the delay with which the prices act on the production" (Gibrat [1935h], 57).

But he never clarifies its interest to solve the curves of supply and demand's problem of estimation, in other words, the problem known as of "the identification" (Epstein [1987], 23-28).

The fact that Gibrat doesn't mention this problem neither its solution shows, according to us, the difficult assimilation of econometric concepts and problems, and the duration of the process of training.

Epistemology and econometrics

The fourth argument relates to epistemology. It should be stressed the existence of a belief, perceptible within X-Crise, relating to the truth of econometric statements. This belief shows how it is difficult to understand the epistemological statute of these statements, a difficulty which is not specific to X-Crise, since the econometric discipline makes its "probabilistic revolution gradually" (Morgan [1990]).

The question of the truth of a scientific statement is clearly raised by Chait. Hence, about assumptions tested by econometric methods,

> "it is important to know if these assumptions are true. For each assumption, one calculates the corresponding coefficient of correlation. If the coefficient is high, one might admit that the assumption was good; if the coefficient is insufficient, one rejects the assumption" (Chait [1938], 12).

The "truth" can thus emerge from the statistical inference. From the same point of view, Pourquié two years earlier mentioned "laws" that econometrics could find :

> "[f]rom a suggested relation will emerge a more or less good law according to the degree of calculation's adjustment to the experimental results. The law will be considered as nearly perfect, when the variations are of the order of the errors relative to the variables' measure" (Pourquié [1936], 26).

Thus, the members of C.P.E.E. seem to believe in the "truth" of the econometric statements, so that economic "law" can be empirically based on.

The perception of this belief probably encouraged Tinbergen, who was present at Chait's conference on econometrics, to reconsider this fundamental question - while at the same time the C.P.E.E. had followed regularly the econometric topicality for at least four years. He thus begins its communication while wanting to give an "overall impression" of its work to S. D. N:

> "[t]his work applies the econometric method whose Mr. Chait spoke the other day here and of which perhaps I could start to give an overall impression to you" (Tinbergen [1938], 26).

Tinbergen thus has the feeling that it is necessary to prepare the ground so that its audience has a good understanding of econometrics. Continuing its talk, Tinbergen initially evokes "the general idea of the method known as of the multiple correlation", in other words, the method known as of ordinary least squares (Tinbergen [1938], 27). Finally he presents the conclusions which one can draw from the use

of this method. The adjustment of the model on the series only allows "a kind of confirmation... *a kind of* confirmation". More precisely, this confirmation leads to probable statements.

> "the role of the statistician can thus be only rather negative here, i.e. he can give a certainty only if the correlation is not good; if the correlation is good, he can only speak about a probability. Indeed, if, in a given case, the correlation is good, that is not a proof that the theory is right; it could be that a combination of other variables still gives you higher or at least such a good correlation. Remain always the responsibility for the theory to the economists. If the economists would agree about, one could say that one approaches the certainty "(Tinbergen [1938], 27).

Thus, Tinbergen specifies the epistemological statute of the econometric statement. They are only probable statements, in no case "true" statements nor "laws". The certainty can only come from the refutation, according to the poppérien meaning of the word. One finds here the probabilism characterizing the econometrics of Haavelmo's program in 1944 (Morgan [1990], 171).

This development seemed necessary, since even Divisia, the main organizer of the econometric development in France (Armatte [1994]), feels obliged to react.

> "I was highly interested by the talk that we have just heard and I would like to formulate some observations on three points which particularly struck me.
>
> 1° As for the reach and the value of the statistical confirmation of the economic theories, I don't fell like a contradictor, rather the contrary; because I believe, indeed, exactly like the lecturer that the failures are the more useful in this matter : when we fail in front of experimental confirmation, we are *sure* that we were mistaken somewhere; on the other hand, the even excellent statistical confirmations do not have a conclusive force; personally, I don't react to these ones since I know a lot of very good confirmations of different theses between which they don't help to choose " (Divisia [1938b], 34).

It is indeed the first time where one presents explicitly, within C. P. E. E., the epistemological statute of the econometric statements. The reaction of Divisia consisting in trying to reduce Tinbergen's probabilism to a common sense's philosophy, betrays an epistemological dissension which is reflected on its work:

> "Divisia seems to miss this fishérian statistics' bend, illustrated by the *Statistical Methods for Research Workers*' success , and stays far from the Cowles Commission and probabilistic and structural Revolution's works which its members institute in econometrics, and that they diffuse through *Econometrica"* (Armatte [1994], 435).

This epistemological vagueness, which is finally not so much surprising relative to the progressive emergence of this discipline, is thus added to the three arguments listed previously to underline the duration of the training of the econometric concepts by Polytechniciens.

Fascinating forecasts

It must be said that, for them, econometrics has to be essentially a means for economic forecast – briefly, a means to make intervention in economic life easier in order to have a solution to the crisis. Gibrat often repeats it in its « Notes on econometrics » from 1934 to 1936.

Gibrat always stresses the significance of forecast. Thus he writes for example

> "the tragedy of the political economy, it is that it did not follow the normal walk of other sciences; the more precise knowledge of the facts did not involve a more intimate union

> between abstract knowledge and the observations. It is now absolutely necessary to achieve the correspondence between the concepts of the theory and the observable magnitudes so as to check if theory fits the observations. After it will be possible to foresee"(Gibrat [1935b], 84).

This last aspect in particular is stressed by Gibrat at the end of Dugé de Bernonville's conference, related to the activity of the *Statistique Générale de France* (Bernonville [1935]). Indeed, for Gibrat, this activity becomes useful only

> "thanks to a deep knowledge of the various techniques brought into play and to the most important theories created for the explanation and the forecast of the economic movement. The mathematical culture is then almost essential" (Gibrat [1935h], 56).

Moreover, he affirms, in conclusion,

> "Morgenstern (*Wirtschaftprognose*, Vienna 1928) has much studied this curious question and, in contradiction with much of writers, he concludes that the forecasts tend to intensify rather than to soften the cycles. This can be admitted rather easily in certain cases, for example when the forecast makes admit a new fall of prices, but wouldn't it be necessary to study even more this problem, and isn't it possible to indicate the cases in which the forecasts could involve other results? This hope enables me to end this conference on a not too pessimistic note" (Gibrat [1935h], 59).

Moreover, Gibrat discusses the relevance of econometric studies, according to their contribution for the forecast to which he is so attached. This aspect of the criticism exerted by Gibrat against econometrics appears thus in the "Notes" IV (Gibrat [1935d]), V (Gibrat [1935e]) and VII (Gibrat [1936a]).

The "Notes" IV, where Gibrat quickly presents Greenstein's work, finish indeed with the consent of a failure. The periodogram's method that Greenstein applies on the annual percentage of the bankruptcies related to the total number of the firms from 1867 to 1932 is "disappointing" according to Gibrat. Indeed, no periodicity really emerges from this work (Gibrat [1935d]), 55). Gibrat is then particularly critical and pessimistic with regard to this work.

> "[I]n this particular case, the result is very disappointing, and besides, are six cycles sufficient to found a forecast ? and should not we be agree with Mr. Greenstein when he writes: "If during the next sixty-six years, we find that the typical duration did not change and that there are certain **known** causes which keep it constant, will we then perhaps be able to anticipate "? In this moment, he writes, it is necessary to wait... " (Gibrat [1935d], 55).

However, according to Gibrat, "[t]he interest of this research is very important for forecast" (*ibid.*).

This aim is logical relatively to the Polytechniciens' first one : to understand and especially to solve the economic crisis thanks to an intervention in the economic life. The interest carried by Polytechniciens within X-Crise with econometrics is due to their concern of wondering about the crisis, its causes, its remedies, in order to intervene in the economic life. This concern is, as one saw, one of the factors at the origin of the group's constitution. Indeed, Polytechniciens tried, with this group, to think about the economic problems of their time.

The study entitled "Reflexions over six months to work" (Bardet [1932])[20] shows it :

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[20] *The Bulletin of the C.P.E.E.* (July 1939, n° 59) will devote even a whole number on this topic scour in work of X-Crise.

> "are we in a simple time-lag between the individual's adaptation and the material possibilities that progress opens to him, and is it enough to provide the current system with a regulator; or […] is it necessary, on the contrary, to adapt human work to individuals' needs, and, for that, to let a supreme authority, whatever its nature (political or economic), the care to systematically ensure equilibrium ?" (*idem*., 48).

More precisely, it is clear that the idea of intervening in economic life to ensure the continuation of a rationality that would otherwise be lost, echoed the function and purpose French engineers had always had in the technical field. This idea – and the importance of plannism among X-Crise members - can be explained by the Saint-Simonian tradition which they held to (Vallon [1935], 17; Etner 1978, 110) [21].

In that, the Polytechniciens rejoin the position defended by the econometricians. Indeed, the latter have, in the Thirties, the will to act, to change the society (Epstein [1987], 8). Work of the econometricians could not thus leave Polytechniciens indifferent. On the contrary, they constitute, for them, an object of a very particular interest as the econometrics team's creation directed by Gibrat within X-Crise testified.

Nevertheless, it will never lead X-Crise to create an econometric laboratory. Gibrat, in his "Notes on Econometrics", will do nothing but present some studies - of Greenstein, Luftalla, Frisch, Moore, Schultz, Tinbergen or Ross, for instance – already realized.

2. 2. A limited interest for mathematical models

The limited interest of Polytechniciens for econometrics is also perceptible for the mathematical models. Admittedly, it is with X-Crisis that one may find the first French mathematical models in economy at the time. But, reading the bulletins of the CPEE, one also have the feeling of a lack of attention - at the very least – for the mathematical works published in the bulletins. Potron's model, so innovative for that time, does not find its audience (*cf*. Abraham-Frois, lendjel [2001]); as for that of Moch, which is discussed only in relation with that of the Guillaume.

In fact, it seems that the Polytechniciens have their model, that of the Guillaume, incensed by Coutrot because it is concerned with the "économique rationnelle", so important for him (*cf* O. Dard [1999]) – and they would be satisfied with it. This mathematical model of the crisis would have beside the virtues required by Polytechniciens since it could be confronted with the empirie through the cinémograme, (simple transposition of the principles of the cinematograph to the dynamic

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[21] This thesis was clearly stated in a discussion by Vallon of Jacques Branger's paper 1935 where the former affirmed that "given their education, the Polytechniciens cannot refuse to be sympathetic to economic planning. In so doing, we will remain true to the Saint-Simonian tradition, which is already a hundred years old and was the tradition of our great forebears, who founded and gave life to the modern French economy" (Vallon 1935, 17). Moreover, on February 20 1937, an entire meeting of X-Crise was devoted to "Saint-Simonism and the Polytechniciens").

representation of the economic phenomena). The empirical work of Simiand could even be interpreted like a confirmation of Guillaume's model's results. Like Louis Vallon notes it, in his obituary of Simiand.

> "[let's] end with a remark. In the work of Simiand, there are an experimental theory of the credit and of representative money which points out the one on "getting into debt" that Mr. George Guillaume supported so brilliantly in front of us. Undoubtedly our complex economic world is far from resembling the simplified "model"; it perhaps even **by nature** can't be assimilated to such a model; a study of this kind makes it still possible to fix a frame of reference useful for the determination of real economical desequilibrium. **The "Economique rationelle"** appears thus like the complement of François Simiand's "**Economique expérimentale"**, exactly like chemistry is one of the essential supports of biology " (Vallon [1935], 68).

Conclusion

This paper intend to show X-Crise's contribution to the rise of the use of quantitative techniques in France during the thirties. As we have seen through Moch's 1933-4 article, X-Crise do support the development of the first macroeconomics model in France and attempts to confront them to facts with a kind of econometric approach. But even though interesting, those attempts were rare and rather rough, using only graphical analysis.

The lack of major theorethical contributions – except for Moch and Potron - by the members of this group of Polytechniciens is probably one of the reason why today economists do not manifest a real interest about them[22] - especially for that period of "high theory" (Shackle [1967]). Nevertheless, X-Crise certainly is the place in France where innovative economic studies were in great demand and long-awaited at that time; where, consequently, these studies were submitted and discussed; where, above all, they could have a great impact on minds. One could even ask if it is not (also) because X-Crise was open to economic modelization that some of the next Polytechniciens' generation, like Roy or Allais, devoted their reflexion to this topic; or, in other words, if the X-Crise Polytechniciens' interest for models does not partly explain Michel Margairaz following judgment that "no doubt X-Crise have eased Ecole Polytechnique's conversion to Economics as well as the State experts to macroeconomics, more or less explicitly inspired by Keynesianism" (Margairaz [1995], 181)[23].

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[22] See, for instance, F. Etner [1987], p.242.
[23] See also Margairaz [1991]..

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